CLAIMS

Having thus described our invention what we claim as new and desire to secure as Letters Patent, is:

SubB1

1. A superconductive composition having a transition temperature greater than 26°K, the composition including a rare earth or near rare earth-like element, a transition metal element capable of exhibiting multivalent states and oxygen, and including at least one phase that exhibits superconductivity at temperature in excess of 26°K.

2. The composition of claim 1, further including an alkaline earth element substituted for at least one atom of said rare earth or rare earth-like element in said composition.

3. The composition of claim 2, where said transition metal is Cu.

4. The composition of claim 3, where said alkaline earth element is selected from the group consisting of B, Ca, Ba, and Sr.

5. The composition of claim 1, where said transition metal element is selected from the group consisting of Cu, Ni, and Cr.

6. The composition of claim 2, where said rare earth or rare earth-like element is selected from the group consisting of La, Nd, and Ce.

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7. The composition of claim 1, where said phase is crystalline with a perovskite-like structure.

8. The composition of claim 2, where said phase is crystalline with a perovskite-like structure.

9. The composition of claim 1, where said phase exhibits a layer-like crystalline structure.

10. The composition of claim 1, where said phase is a mixed copper oxide phase.

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11. The composition of claim 1, where said composition is comprised of mixed oxides with alkaline earth doping.

Sub C2

12. A superconducting combination, including a superconductive composition having a transition temperature > 26°K,

means for passing a superconducting electrical current through said composition while said composition is at a temperature > 26°K., and

cooling means for cooling said composition to a superconducting state at a temperature in excess of 26°K.

13. The combination of claim 12, where said superconductive composition includes a transition metal oxide.

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14. The combination of claim 12, where said superconductive composition includes Cu-oxide.

15. The combination of claim 12, where said superconductive composition includes a multivalent transition metal, oxygen, and at least one additional element.

16. The combination of claim 15, where said transition metal is Cu.

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17. The combination of claim 15, where said additional element is a rare earth or rare earth-like element.

18. The combination of claim 15, where said additional element is an alkaline earth element.

19. The combination of claim 12, where said composition includes a perovskite-like superconducting phase.

20. The combination of claim 12, where said composition includes a substituted transition metal oxide.

21. The combination of claim 20, where said substituted transition metal oxide includes a multivalent transition metal element.

Sub J'

22. The combination of claim 20, where said substituted transition metal oxide is an oxide of copper.

23. The combination of claim 20, where said substituted transition metal oxide has a layer-like structure.

Sub B2)

24. A method including the steps of forming a transition metal oxide having a phase therein which exhibits a superconducting state at a critical temperature in excess of 26° K,

lowering the temperature of said material at least to said critical temperature to produce said superconducting state in said phase, and

Sub B2) Cont.

~~passing an electrical supercurrent through said transition metal oxide while it is in said superconducting state.~~

b

25. The apparatus ~~method~~ of claim 24, where said transition metal oxide is comprised of a transition metal capable of exhibiting multivalent states.

Sub g'

b

26. The apparatus ~~method~~ of claim 24, where said transition metal oxide is comprised of a Cu oxide.

Sub B3)

~~27. A superconducting composition having a transition temperature in excess of 26°K, said composition being a substituted Cu-oxide including a superconducting phase having a structure substantially close to the orthorhombic-tetragonal phase transition of said composition.~~

b

28. The superconducting apparatus ~~composition~~ of claim 27, where said substituted Cu-oxide includes a rare earth or rare earth-like element.

Sub g'

b

29. The ~~composition~~ superconducting apparatus of claim 27, where said substituted Cu-oxide includes an alkaline earth element.

b

30. The ~~composition~~ superconducting apparatus of claim 29, where said alkaline earth element is atomically large with respect to Cu.

Sub B1

b

31. The ~~composition~~ superconducting apparatus of claim 27, where said composition has a crystalline structure which enhances electron-phonon interactions to produce superconductivity at a temperature in excess of 26°K.

Sub B2

32. The composition of claim 31, where said crystalline structure is layer-like, enhancing the number of Jahn-Teller polarons in said composite.

Sub B3

33. A superconducting composition having a superconducting onset temperature in excess of 26°K., the composition being comprised of a copper oxide doped with an alkaline earth element where the concen-

tration of said alkaline earth element is near to the concentration of said alkaline earth element where the superconducting copper oxide phase in said composition undergoes an orthorhombic to tetragonal structural phase transition.

b

34. A superconducting apparatus comprising a composition having a superconducting onset temperature in excess of 26°K, the composition being comprised of a mixed copper oxide doped with an element chosen to create Cu^{3+} ions in said composition.

b

35. The superconducting apparatus ~~composition~~ of claim 34, where said doping element includes an alkaline earth element.

36. A combination comprising:

a composition having a superconducting onset temperature in excess of 26°K, said composition being comprised of a substituted copper oxide exhibiting mixed valence states and at least one other element in its crystalline structure,

means for passing a superconducting electrical current through said composition while said composition is at a temperature in excess of 26°K, and

cooling means for cooling said composition to a superconducting state at a temperature in excess of 26°K.

37. The combination of claim 36, where said at least one other element is an alkaline earth element.

38. The combination of claim 36, where said at least one other element is an element which creates Cu^{3+} ions in said composition.

39. The composition of claim 36, where said at least one other element is an element chosen to create the presence of both Cu^{2+} and Cu^{3+} ions in said composition.

Sub B5

40\. A superconductor exhibiting a superconducting onset at a temperature in excess of 26°K, said superconductor being comprised of at least four elements, none of which is itself superconducting.

b Sub G'

41\. The apparatus ~~superconductor~~ of claim 40, where said elements include a transition metal and oxygen.

b Sub C1

42\. A apparatus ~~superconductor~~ having a superconducting onset temperature greater 26°K, said superconductor being a doped transition metal oxide, where said transition metal is itself non-superconducting.

b

43\. The apparatus ~~superconductor~~ of claim 42, where said doped transition metal oxide is multivalent in said superconductor.

b Sub G'

44\. The apparatus ~~superconductor~~ of claim 42, further including an element which creates a mixed valent state of said transition metal.

b

Sub F1,2

45. The ~~superconductor~~ apparatus of claim 43, where said transition metal is Cu.

b

Sub C9

46. ~~A~~ An apparatus comprising superconductor having a superconducting onset temperature greater than 26°K, said superconductor being an oxide having multivalent oxidation states and including a metal, said oxide having a crystalline structure which is oxygen deficient.

Sub F1,2

47. The superconductor of claim 46, where said transition metal is Cu.

Sub C9

48. A superconductive composition comprised of a transition metal oxide having substitutions therein, the amount of said substitutions being sufficient to produce sufficient electron-phonon interactions in said composition that said composition exhibits a superconducting onset at temperatures greater than 26°K.

49. The composition of claim 48, where said transition metal oxide is multivalent in said composition.

50. The composition of claim 48, where said transition metal is Cu.

51. The composition of claim 48, where said substitutions include an alkaline earth element.

Sub B1

52. The composition of claim 48, where said substitutions include a rare earth or rare earth-like element.

53. A superconductor comprised of a copper oxide having a layer-like crystalline structure and at least one additional element substituted in said crystalline structure, said structure being oxygen deficient and exhibiting a superconducting onset temperature in excess of 26°K.

54. The superconductor of claim 53, where said additional element creates a mixed valent state of said copper oxide in said superconductor.

Sub J1

Sub E10

55. A combination, comprising:

a transition metal oxide having an oxygen deficiency, said transition metal being non-superconducting and said oxide having multivalent states,

means for passing an electrical superconducting current through said oxide while said oxide is at a temperature greater than 26°K, and

cooling means for cooling said oxide in a superconducting state at a temperature greater than 26°K.

56. The combination of claim 55, where said transition metal is Cu.

Sub J1

Sub C1

57. A combination including;

a superconducting oxide having a superconducting onset temperature in excess of 26°K and containing at least 3 non-superconducting elements,

means for passing a supercurrent through said oxide while said oxide is maintained at a temperature greater than 26°K, and

means for maintaining said oxide in a superconducting state at a temperature greater than 26°K.

58. A combination, comprised of:

a copper oxide superconductor including an element which creates a mixed valent state in said oxide, said oxide being crystalline and having a layer-like structure,

means for passing a supercurrent through said copper oxide while it is maintained at a temperature greater than 26°K, and

means for cooling said copper oxide to a superconductive state at a temperature greater than 26°K.

59. A combination, comprised of:

a superconducting ceramic-like material having an onset of superconductivity at a temperature in excess of 26°K.,

means for passing a supercurrent through said superconducting ceramic-like material while said ceramic-like material is maintained at a temperature in excess of 26°K., and

means for cooling said superconducting ceramic-like material to a superconductive state at a temperature greater than 26°K.

60. A superconductor comprised of a transition metal oxide, and at least one additional element, said superconductor having a distorted crystalline structure characterized by an oxygen deficiency and

exhibiting a superconducting onset temperature in excess of 26°K.

61. The superconductor of claim 60, where said transition metal is Cu.

62. A superconductor comprised of a transition metal oxide and at least one additional element, said superconductor having a distorted crystalline structure characterized by an oxygen excess and exhibiting a superconducting onset temperature in excess of 26°K.

63. The superconductor of claim 62, where said transition metal is Cu.

64. A combination, comprising:

a mixed copper oxide composition having enhanced polaron formation, said composition including an element causing said copper to have a mixed valent

state in said composition, said composition further having a distorted octahedral oxygen environment leading to a T_c greater than 26°K.,

means for providing a supercurrent through said composition at temperatures greater than 26°K., and

cooling means for cooling said composition to a temperature greater than 26°K.

65. A superconducting composition exhibiting superconductivity at temperatures greater than 26°K, said composition being a ceramic-like material in the RE-AE-TM-O system, where RE is a rare earth or near rare earth element, AE is an alkaline earth element, TM is a multivalent transition metal element having at least two valence states in said composition, and O is oxygen, the ratio of the amounts of said transition metal in said two valence states being determined by the ratio RE : AE.

66. A superconductive composition having a transition temperature greater than 26°K, the composition in-

cluding a multivalent transition metal oxide and at least one additional element, said composition having a distorted orthorhombic crystalline structure.

Sub E

67. The composition of claim 66, where said transition metal oxide is a mixed copper oxide.

68. The composition of claim 67, where said one additional element is an alkaline earth element.

Sub C

69. A superconductive combination, comprising:

a superconducting composition exhibiting a superconducting transition temperature greater than 26°K, said composition being a transition metal oxide having a distorted orthorhombic crystalline structure, and

means for passing a superconducting electrical current through said composition while said composition is at a temperature greater than 26°K.

70. The combination of claim 69, where said transition metal oxide is a mixed copper oxide.

71. The combination of claim 70, where said mixed copper oxide includes an alkaline earth element.

72. The combination of claim 71, where said mixed copper oxide further includes a rare earth or rare earth-like element.

73. A method for making a superconductor having a superconducting onset temperature > 26°K, said method including the steps of:

preparing powders of oxygen-containing compounds of a rare earth or rare earth-like element, an alkaline earth element, and copper,

mixing said compounds and firing said mixture to create a mixed copper oxide composition including said alkaline earth element and said rare earth or rare earth-like element, and

annealing said mixed copper oxide composition at an elevated temperature less than about 950°C in an atmosphere including oxygen to produce a superconducting composition having a mixed copper oxide phase exhibiting a superconducting onset temperature greater than 26°K, said superconducting composition having a layer-like crystalline structure after said annealing step.

74. The method of claim 73, where the amount of oxygen incorporated into said composition is adjusted by said annealing step, the amount of oxygen therein affecting the critical temperature T_c of the superconducting composition.

Cut 71

75. A method for making a superconductor having a superconducting onset temperature greater than 26°K, said superconductor being comprised of a rare earth or rare earth-like element (RE), an alkaline earth element (AE), copper (CU), and oxygen (O) and having the general formula RE-AE-CU-O, said method including the steps of combining said rare earth or rare earth-like element, said alkaline earth earth

element and said copper in the presence of oxygen to produce a mixed copper oxide including said rare earth or rare earth-like element and said alkaline earth element therein, and

Sub B'

heating said mixed copper oxide to produce a superconductor having a crystalline layer-like structure and exhibiting a superconducting onset temperature greater than 26°K, the critical transition temperature of said superconductor being dependent on the amount of said alkaline earth element therein.

76. The method of claim 75, where said heating step is done in an atmosphere including oxygen.

Sub C14

77. A combination, comprising:

a mixed copper oxide composition including an alkaline earth element (AE) and a rare earth or rare earth-like element (RE), said composition having a layer-like crystalline structure and multi-valent oxidation states, said composition

exhibiting a substantially zero resistance to the flow of electrical current therethrough when cooled to a superconducting state at a temperature in excess of 26°K, and

electrical means for passing an electrical supercurrent through said composition when said composition exhibits substantially zero resistance at a temperature greater than 26°K.

78. The combination of claim 77, where the ratio (AE,RE) : Cu is substantially 1:1.

79. The combination of claim 77, where the ratio (AE,RE) : Cu is substantially 1:1.

Sub B'

80. The combination of claim 77, where said crystalline structure is perovskite-like.

81. The combination of claim 77, where said mixed copper oxide composition has a non-stoichiometric amount of oxygen therein.

82. A method for making a superconductor having a superconducting onset temperature greater than 26°, said superconductor being comprised of a rare earth or rare earth-like element (RE), an alkaline earth element (AE), a transition metal element (TM), and oxygen (O) and having the general formula RE-AE-TM-O, said method including the steps of combining said rare earth or rare earth-like element, said alkaline earth element and said transition metal element in the presence of oxygen to produce a mixed transition metal oxide including said rare earth or rare earth-like element and said alkaline earth element therein, and

Sub B1

heating said mixed transition metal oxide to produce a supercoductor having a crystalline layer-like structure and exhibiting a superconducting onset temperature greater than 26°K, said superconductor having a non-stoichiometric amount of oxygen therein.

83. The method of claim 82, where said transition metal is copper.

84. A superconducting combination, comprising:

a mixed transition metal oxide composition containing a non-stoichiometric amount of oxygen therein, a transition metal and at least one additional element, said composition having substantially zero resistance to the flow of electricity therethrough when cooled to a superconducting state at a temperature greater than 26°K, and

electrical means for passing an electrical supercurrent through said composition when said composition is in said superconducting state at a temperature greater than 26°K.

85. The combination of claim 84, where said transition metal is copper.

Sub B6

~~86. A method, comprising~~ the steps of:

SubB6 cont.

~~forming a composition including a transition metal, a rare earth or rare earth-like element, an alkaline earth element, and oxygen, where said composition is a mixed transition metal oxide having a non-stoichiometric amount of oxygen therein and exhibiting a superconducting state at a temperature greater than 26°K,~~

~~cooling said composition to said superconducting state at a temperature greater than 26°K, and~~

~~passing an electrical current through said composition while said composition is in said superconducting state.~~

87. The method of claim 86, where said transition metal is copper.

Sub F'

88. A method, including the steps of:

forming a composition exhibiting a superconductive state at a temperature in excess of 26°K,

cooling said composition to a temperature in excess of 26°K at which temperature said composition exhibits said superconductive state, and

passing an electrical current through said composition while said composition is in said superconductive state.

89. The method of claim 88, where said composition is comprised of a metal oxide.

90. The metal of claim 88, where said composition is comprised of a transition metal oxide.

91. (ADDED) A combination, comprising:

a composition exhibiting the onset of a DC substantially zero resistance state at an onset temperature in excess of 30K, and

means for passing an electrical current through said composition while it is in said substantially zero resistance state.

92. (ADDED) The combination of claim 91, where said composition is a copper oxide.

93. (ADDED) An apparatus, comprising:

a mixed copper oxide material exhibiting an onset of superconductivity at an onset temperature greater than 26K, and

means for producing an electrical current through said copper oxide material while it is in a superconducting state at a temperature in excess of 26K.

94. (ADDED) The apparatus of claim 93, where said copper oxide material exhibits a layer-like crystalline struc-

95. (ADDED) The apparatus of claim 93, where said copper oxide material exhibits a mixed valence state.

Sub 3'